Procedure: C-A-OSH-ACC
Revision: 00
Revision Date: 5/19/03

COLLIDER-ACCELERATOR DEPARTMENT

Title: OSH Initial Assessment Review for Accelerators

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Group: ESHQ

Approvals

*Signature on File*____________________ Date:____________
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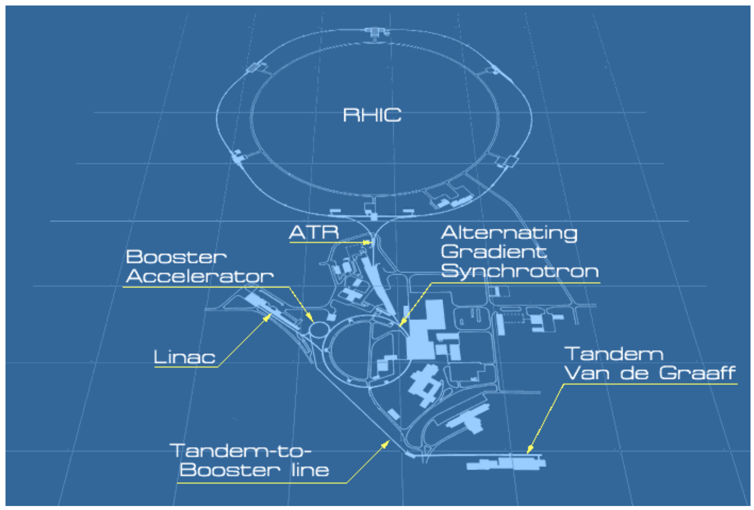
*Signature on File*____________________ Date:____________
Collider-Accelerator Department Chairman

(Indicate additional signatures)

Y	N		
[]	[]	FS Representative:________________	Date:____________
[]	[]	Radiological Control Coordinator:________________	Date:____________
[]	[]	Chief ME:________________	Date:____________
[]	[]	Chief EE:________________	Date:____________
x	[]	ESH Coordinator: *Signature on File*________________	Date:____________
[]	[]	QA Manager:________________	Date:____________
[]	[]	Other:________________	Date:____________

BROOKHAVEN NATIONAL LABORATORY
INITIAL ASSESSMENT FORM

<table>
<tr><td>ID:</td><td>C-A-OSH-ACC</td><td colspan="2">Revision 00</td></tr>
<tr><td>Work Area Name:</td><td colspan="3">Accelerators</td></tr>
<tr><td>Work Area Description:</td><td colspan="3">LINAC, TVDG, Tandem to Booster, Booster, AGS, AtR, RHIC.

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<tr><td>Dept./Div.:</td><td colspan="3">Collider-Accelerator Department (C-AD)</td></tr>
<tr><td>Dept. Code:</td><td colspan="3">AD</td></tr>
<tr><td>Building(s):</td><td colspan="3">901A,913, 914,930, 1005</td></tr>
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1. General Information for Accelerators and Experimental Areas

Primary areas are areas where beam is fully enclosed. During running periods, this includes the Tandem van de Graaff, Tandem to Booster line (TTB), Linac, Booster, AGS, AGS to RHIC line (AtR), RHIC and RHIC interaction regions. It also includes the SEB port, the switchyard and the beam lines (A, B, C and D) up to the target stations housed in Building 912. Primary areas also include Building 927, which encloses the FEB port that gives rise to the U, V and upstream portion of the W lines. The U and V lines are used for high-intensity proton experiments using fixed targets and are considered primary areas. All primary areas are fully enclosed by shielding or fences. They are generally arranged as shielded areas with interlocked gates.

Secondary areas are beam lines and enclosures that extend beyond the primary lines. They are normally labeled A1, A2, C1, C4, etc. They are not necessarily fully enclosed; that is, they may not have a barrier on the roof or they may not be completely caged. They are generally arranged as fenced areas with interlocked gates. The radiation hazard in secondary areas is less than primary beam areas. A strict radiation hazard classification scheme was adopted by the ion accelerator complex in the 1970s and is delineated in C-AD OPM Procedure 9.1.11.

Secondary areas are enclosed in larger structures referred to as experimental halls. The five-acre structure, Building 912, houses all slow-extracted-beam lines that give rise to thirteen secondary beam-lines. Building 919 houses the downstream portion of the V1 line which is used to enclose secondary beam from the fixed V target.

In addition to radiation hazards, primary, secondary and experimental areas may contain hazards posed by heavy objects, mechanical equipment, electrical systems, magnetic fields, toxic or flammable materials, and fire.

2. Detailed Process and Hazard Descriptions for Accelerators and Experimental Areas

IONIZING RADIATION HAZARDS

The external radiation hazard is due to loss of beam at a single point inside an enclosure with potential exposure of personnel from radiation that penetrates through thin shielding. Inadvertent beam losses are not rare events, they may happen several times per shift. For example, power to a bending magnet may be disrupted. In the collider-accelerator complex, beam faults are addressed immediately, and operators retune the beam or reduce intensity according to established OPM procedure. Additionally, personnel are protected during a fault by appropriate shielding and by barriers such as fences that keep people at a safe distance.

The design goal for the ion accelerators is no more than 20 mrem per fault. C-A Department OPM procedures prohibit more than four faults at a given location in one hour. Because shielding is relatively inexpensive, beam faults typically produce a fraction of a mrem exposure. Offsite risk from inadvertent beam loss at the accelerators is insignificant.

Sweep procedures are used to remove people from an enclosure prior to the onset of operations with beam. Once the beam is on, interlocked gates protect people from contact with the beam hazards directly.

Accidental exposure of workers to contamination is rare and may happen if a target fails during high-intensity proton operations. Because there is a relatively minor inventory of dispersible radioactivity in a failed target, there is no impact to public. That is, experience shows the majority of radioactivity will be firmly entrained in the target metal and will not become airborne.

Targets are designed and fabricated to withstand the quasi-static and dynamic thermal stresses from a high-intensity pulsed beam. If a target is heated slowly enough and uniformly enough, then it will not break. Our experience with contamination events is that the severity of contamination is negligible. That is, significant internal exposures to radioactive materials have not occurred over the past 40 years of operations at C-A facilities.

Several primary beam areas such as the Linac, Booster Ring, AGS Ring, Switchyard and Target Caves are High Radiation Areas during shutdown or maintenance days. The residual radiation level may be greater than 100 mrem per hour in these areas, and up to 50,000 mrem per hour at targets. Generally, there are not high levels of radiation all over the area; it is usually at Hot Spots such as the center of magnet gaps. In order to control radiation exposure during maintenance periods in these locked enclosures, individuals are trained and authorized. Additionally, job-specific radiation work permits are used to control work in High Radiation Areas.

The C-AD has a limited number of beta and gamma emitting sources. These are available to be loaned as needed. Care is taken to ensure sources brought into the C-AD facilities are not lost, as this might result in unnecessary exposure and widespread contamination if a source is damaged. Sources are not allowed to be taken into an uncontrolled area nor away from the C-AD complex. The C-AD HP Office is contacted if sources are moved within the complex. Sources owned or brought into the complex are leak checked by the HP Office annually, or a valid certificate of a leak check accompanies the source.

Environmental radiation-protection issues include sky-shine, which is high-energy radiation interacting in the sky above the accelerators that gets reflected back to the ground in the form of low-energy radiation, induced radioactivity in cooling water and fire-protection water, cooling tower emissions of radioactive gases to air, induced radioactivity in air, induced radioactivity in beam-line components that later enter a waste stream, and induced radioactivity in soil. Procedures and systems have been established to eliminate environmental emissions, or reduce them to a level of no significant impact.

HAZARDOUS OR TOXIC MATERIAL HAZARDS

Although the dominant shield materials are concrete and iron, lead shielding is sparsely found throughout the complex. In any handling operation, routine industrial hygiene procedures are followed. In case of fire, some lead may be heated and released in smoke. People would be expected to stay out of smoke if a fire occurs, thus exposure to lead vapors is not considered a hazard.

Materials Safety Data Sheets are used by personnel who work with hazardous chemicals. Personnel are also trained in Hazard Communication. The range of materials is typical for an industrial complex of this size. The hazards from these materials are in the “routinely accepted” category and pose minor hazards within the complex. In particular, hazardous and toxic materials pose no significant impact off-site.

Uranium shield block is used to accommodate both shielding and space requirements in Building 912. The high density of uranium allows one to fit the beam-line shielding within the building confines whereas iron, concrete or heavy concrete would require more space than is available.

The toxicological hazard from depleted uranium is greater than the radiological hazard. The maximum credible intake in a fire at C-AD was determined to be 13.5 mg and this intake would not likely to lead to kidney impairment. The committed effective dose equivalent from inhalation of 13.5 mg of U (uranium dioxide, Class Y) is 0.8 rem.

It was concluded that toxic hazard from fire in Building 912 was low. An external fire would not reach the uranium shield block. The probability of renal injury or significant radiation dose was determined to be extremely remote. That is, the probability of occurrence could not be distinguished from zero.

FLAMMABLE OR COMBUSTIBLE MATERIAL HAZARDS

Welding gases and flammable/explosive gases in experimental detectors is widely used and stored according to National Fire Protection Association codes and standards applicable to experimental installations. Gases are stored in compressed gas cylinders which meet DOT specifications. Large quantities of stored gas are forbidden in accelerators and experimental areas, and staff and users are generally limited to using 100 to 200 lb. cylinders inside of buildings. No offsite threats to the public are expected should a cylinder fail.

Combustible loading of beam lines consists of magnets, power and control cables, and beam diagnostic equipment. None of the materials are highly flammable, and with the possible exception of small amounts of control cable, all are expected to self extinguish upon de-energizing of electric power. Induced radioactivity is deeply entrapped in magnets and concrete shielding, and is not dispersible in a fire. No off-site threats to the public are expected from a fire.

The personnel risks associated with the fire hazard are considered low considering the type of building construction, the available exits, the fire detection systems, the fire alarm systems, and the relative fire-safety of the components and wiring. The fire protection of some accelerator buildings is improved by the installation of sprinkler systems. Emergency power and lighting is available in all parts of the accelerator complex and travel distances to exits do not present a problem.

The maximum travel distance from any point to an exit is less than 300 feet and therefore within the allowable distance. Sprinklers are installed in some accelerator facilities such as the Booster. The smoke exhaust system, emergency lighting, nonflammable construction and low hazard fuel loading make the AGS and RHIC Ring structures acceptable. The limited occupancy of the Rings is such that the limited number of escape hatches does not introduce substantial additional risk.

ELECTRICAL ENERGY HAZARD

Hazards leading to personnel injury include electrical shock and high current arcing. Electrical shock presents the greatest hazard. High voltages are present in many parts of the accelerator complex. These areas include: the main magnet power supply, other magnet power supplies, kicker systems, rf systems and their power supplies, experimental area equipment, and, the most commonly encountered, ac distribution systems from 480 V 3-phase down to the 208/120 volt local distribution systems.

Regardless of the voltage involved, high current systems may create arcs capable of causing severe flash burns, direct burns, or molten metal splattering. Even though circuit breakers may actuate, the short-circuit capability of many systems is many tens of thousands of amperes and severe damage or injury can occur before the breaker trips.

Procedures and proper equipment design are used to reduce the potential for electric shock. Accidents are eliminated or minimized by the application of proper equipment design and design reviews, quality assurance programs, component and equipment testing and personnel training.

Electrical hazards pose only minor on-site impact potential and negligible off-site impact potential.

OXYGEN DEPLETION HAZARDS

Oxygen depletion hazards (ODH) occur when an enclosed space is designed into a facility or experimental structure. With the exception of the RHIC tunnel, RHIC compressor buildings and Building 919, the accelerators, transfer lines and experimental areas do not have sources of cryogenic fluids in which a large volume of cryogenic liquid can be released to create an ODH. Fixed-target experimental areas where ODH may occur are typically man-size, walk-in trenches throughout the experimental areas. In order to eliminate the potential for loss of life or injury, certifications/permits are required for entry inside confined spaces at the accelerator complex, and where appropriate, atmosphere-testing prior to entry, entry procedures, alarming oxygen monitors, escape packs, exhaust fans and posting are also used.

There is no impact on the public or the environment for ODH.

MAGNETIC FIELD AND ELECTROMAGNETIC RADIATION HAZARDS

High direct current magnetic fields may be present in accelerator and experimental area magnets, particularly spectrometer magnets. Limits of exposure are such that the whole body is not allowed in fields greater than 600 gauss on a daily basis (8-hour time-weighted average), and the extremities are not allowed in fields greater than 6000 gauss (8-hour time-weighted average). Other hazards associated with strong magnetic fields are reaction with heart pacemakers or other medical implants and the potential physical injury of carrying ferrous objects near a strong field. Areas with strong magnetic fields are fenced and posted with appropriate warnings. Cardiac pacemaker wearers are not allowed to be exposed to fields greater than 5 gauss.

High magnetic fields are routinely encountered by the public in conjunction with Magnetic Resonance Imaging. Lower level magnetic fields are routinely encountered in the home due to AC power use.

Many areas contain high power rf systems that generate large fields of electromagnetic radiation in the frequency range of a few hundred kilohertz to a few hundred megahertz. These systems, for proper operation of the accelerator, are thoroughly shielded to prevent leakage radiation, thus minimizing this hazard. Leakage of radio-frequency radiation from electronic equipment is controlled by using RFI gaskets. The rf stations in the rings may be powered when the rings are accessible, but local barriers are used to restrict personnel access.

Exposure of personnel to magnetic fields and rf radiation is in compliance with SBMS requirements. Access to the rings is prohibited when the main magnets are powered; when necessary, access is permitted for personnel authorized via a Class D working hot permit. Static or remnant magnetic fields present in ring and transport magnets do not warrant special controls other than appropriate warning signs.

There are no off-site or environmental impacts associated with magnetic fields and electromagnetic radiation at the ion accelerators.

THERMAL ENERGY HAZARDS

Heat sources such as soldering irons and vacuum heating blankets exist in several areas of the accelerator complex. Skin contact with heat sources may cause burns. These hazards are mitigated by safety reviews and compliance with SBMS requirements; for example, shielding or posting warnings near hot surfaces. This hazard is limited in scope and poses no hazard outside the complex.

CRYOGENIC TEMPERATURE HAZARDS

Cryogenic liquids exist in several areas of the accelerator complex. Skin contact with cryogenic materials due to spills or splashes may cause freezing or "cryogenic burns." These hazards are mitigated by safety reviews and compliance with SBMS requirements; for example, requiring the use of gloves and splash goggles when handling open containers of cryogenic fluids. This hazard is limited in scope and poses no hazard outside the complex.

KINETIC ENERGY HAZARDS

Kinetic energy hazards are associated with motorized materials handling equipment and with the operation of hand and shop tools. These hazards are mitigated by safety reviews and compliance with SBMS requirements; for example, machine guarding. This hazard is limited in scope and poses no hazard outside the complex.

POTENTIAL ENERGY HAZARDS

Potential energy hazards are those associate with compressed gases and vacuum windows, as well as those associated with hoisting and rigging operations. These hazards are mitigated by safety reviews and compliance with SBMS requirements; for example, by designing pressure and vacuum vessels to the ASME code, and by setting requirements for the training and qualification of operators, riggers, inspectors, and trainers who use cranes, forklifts, man lifts, hoists, in-plant powered industrial trucks, and rigging equipment.

This hazard is limited in scope and poses no hazard outside the complex.

3. Controls in-Place or Planned Controls

IONIZING RADIATION HAZARDS

A. Direct Radiation

Possible Consequences:

- Accidental external radiation exposure from beam faults producing greater than 20 mrem in an hour
- No impact to public

Potential Initiators:

- Shield degradation
- Failure to follow both the design procedure and fault study procedure for new shields
- Loss of shield configuration control
- Barrier failure
- Person defeats barrier
- Door interlock failure
- Failure to respond to radiation alarms

Hazard Mitigation:

- Fault studies of shielding
- Shield drawing configuration control
- Radiation Safety Check-off List completed prior to operating machines or beam lines where shields have been modified
- Fence and barrier inspection by operators during sweep procedure
- Formal design reviews for radiation safety for all shield modifications
- Facility specific training for all personnel and Users
- Formal job assessments
- Conduct of Operations procedures and training records
- Formal OPM procedures for MCR Operator response to radiation alarms
- PAAA enforcement
- Radiation shielding and barriers designed to reduce the worst case accident exposure to less than 20 mrem per event
- Maximum pulse repetition rate of 1000 pulses in an hour
- A dual, independent, fail-safe protection system to control access to High Radiation Areas
- Radiation monitors to alarm in the Main Control Room and to turn the beam off if unusual radiation levels occur
- A loss monitor system and fast-beam interrupt system primarily designed to protect equipment and unwarranted soil-shield activation
- A system of radiation work permits
- Radiation Worker training
- Work planning

B. Contamination

Possible Consequences:

- Accidental exposure of workers to contamination
- No impact to public

Potential Initiators:

- Failure to follow the design review procedure for targets
- Failure to follow rules for entry or work in Contamination Areas
- Improper target fabrication
- Target intensity limit exceeded
- Target temperature interlock failure

Hazard Mitigation:

- Radiation Safety Committee review of targets
- Mechanical engineering design review of targets
- Target intensity limits approved by Radiation Safety Committee and promulgated by operations procedures
- Radiation Safety Check-off List completed by responsible parties and concurred on by MCR Operations Coordinator prior to sending beam to targets
- Operators trained on procedure that lists the individual target intensity limits for each running period
- Air-flow barriers on doors leading to potentially contaminated target caves
- No HVAC in beam lines or target caves except at NSRL where beam intensity is low
- Contamination worker training for all potentially affected personnel
- Formal job assessments
- Conduct of Operations procedures and training records
- Water-cooled targets
- Target design which accounts for dynamic and quasi-static thermal stresses
- Fail-safe target temperature interlocks
- Contamination surveys at target gates
- A system of radiation work permits
- Contamination Worker training
- Work planning

HAZARDOUS OR TOXIC MATERIAL HAZARDS

Possible Consequences:

- Accidental exposure leading to personnel injury
- Un-permitted environmental release
- Negligible off-site impact

Potential Initiators:

- Cooling pipe break on systems with ethylene glycol
- Oil leak from capacitors, transformers, pumps, motors
- Unsafe practices for handling hazardous and toxic materials
- Fire near uranium shield blocks

Hazard Mitigation:

- Approved line organization procedures and training for hazardous waste handling
- Hazard Communication training
- Labeling of pipes
- Annual inventory of chemical and hazardous materials
- Annual inventory, inspection and tracking all PCB containing devices
- Annual inventory of tanks containing oil
- Annual inspection of transformer yards
- Annual inspection of tanks
- Specific hazard training (e.g., Beryllium, asbestos)
- Limiting the amount of hazardous materials in process
- Work planning

FLAMMABLE OR COMBUSTIBLE MATERIAL HAZARDS

Possible Consequences:

- Loss of life or severe injury
- Damage to components or facilities
- Impact on the physics program due to fire-related interruptions
- Insignificant impact on the environment due to releases as a result of fire

Potential Initiators:

- The common initiators in an accelerator fire are damaged or improperly connected electrical cables
- Less common initiators are failed capacitors in pulse-forming networks, improper fusing of electronics boards or failed motor starter circuits
- Ignition of flammable gases in the experiments
- Ignition of flammable liquids in the experiments

Hazard Mitigation:

- Sprinklers or other protection systems for high-value experimental equipment
- High sensitivity fire detection systems
- Selection of materials that reduce the potential for flame spread
- Emergency exhaust ventilation systems
- The use of strategically located exits and audible alarms to reduce the potential for loss of life during an emergency
- Elimination of potential ignition sources in experimental areas
- On-site fire/rescue organization
- Emergency planning and drills
- Limits on flammable gas or liquid inventory and on flow rates in the experiments
- Requirements for safety review of experiments or accelerator modifications
- Compliance with the Life Safety Code, NFPA 101, Chapters 1-6
- Compliance with the DOE Orders 420.1A, Facility Safety, and 440.1A, Worker Protection Management for DOE Federal and Contractor Employees
- Use of fire wire fire-detection systems on experimental equipment
- Electrical energy interlocks tripped by heat or smoke detectors
- Regular maintenance of electrical equipment
- Using containers that meet the criteria of Underwriters Laboratories or Factory Mutual for flammable materials
- Identifying and posting hazardous locations for flammable or combustible materials storage or use
- Written procedures to temporarily impair fire detection or fire protection systems
- Using a fire watch and a permit for cutting and welding activities
- Work planning

ELECTRICAL ENERGY HAZARD

Possible Consequences:

- Electrocution death and injury
- Electrical arcing and molten-metal spray injury
- No impact to public

Potential Initiators:

- Unsafe practices

Hazard Mitigation:

- Approved line organization procedures and training for specific tasks involving electrical safety issues
- Control zones around energized parts with signs and barriers
- Procedures and training
- Use of permits to work hot
- Performance of a job safety-analysis in order to identify and mitigate the hazard of electrocution

- Lock out and tag out procedures
- Equipment and training to isolate the source of energy in the system
- Use of a safety watch or two-man rule where appropriate
- Not allowing Users to work on power distribution or connection to electrical power
- Work planning

OXYGEN DEPLETION HAZARDS

Possible Consequences:

- Asphyxiation

Potential Initiators:

- Inadvertent entry into ODH areas

Hazard Mitigation:

- Posted Confined Spaces in accordance with SBMS requirements
- Posted ODH areas in accordance with SBMS requirements
- Written procedures for purging the hazardous gases from the experimental equipment
- Determining the O_2 level using an oxygen meter prior to entry
- Fixed O_2 meters and alarms in ODH areas
- Exhaust fans and escape packs where appropriate
- Design reviews and functional testing of the ODH alarm system before operations
- Work planning

MAGNETIC FIELD AND ELECTROMAGNETIC RADIATION HAZARDS

Possible Consequences:

- Reaction with medical implants
- Magnetic pull of heavy metal object through persons hand and into magnet iron with resultant crush type-injury of hand
- Hyperthermia (rf)
- Cataracts (rf)
- Lenticular opacities (rf), LASER

Potential Initiators:

- Inadvertent exposure to stray magnetic field near spectrometer magnet or other large magnet
- Exposure to rf radiation from rf device or light from a LASER

Hazard Mitigation:

- Areas with strong magnetic fields are fenced and posted with appropriate warnings

- Magnets such as large spectrometer magnets undergo an environmental review before turn on to ensure signs and postings are present and to ensure loose ferrous objects are not present
- Routine measurement of magnetic fields around spectrometer magnets on the experimental floor to ensure fencing and posting are located appropriately
- Design reviews and functional testing before operations
- Doors to the facilities are posted with warnings for persons wearing a cardiac pacemaker
- Local barriers are placed around rf stations in the accelerators
- RFI gaskets are used on equipment to prevent rf radiation leakage
- Routine monitoring for rf radiation to determine if gaskets are effective
- Eye protection during LASER operations
- Interlocks on LASERs
- Work planning

THERMAL ENERGY HAZARDS

Possible Consequences:
- Burns
- Fires

Potential Initiators:
- Contact with hot surfaces of machinery
- Contact with soldering irons
- Improper protective clothing for cutting and welding operations

Hazard Mitigation:
- Posting and guarding hot surfaces
- Review of installation and operating procedures by the safety committees
- Design reviews and functional testing before operations
- Cutting and welding conducted by trained personnel only
- Boundaries for cutting and welding are posted
- Cutting and welding permit
- Work planning

CRYOGENIC TEMPERATURE HAZARDS

Possible Consequences:
- Burns

Potential Initiators:
- Spills of cryogenic liquids
- Contact with cold lines associated with liquid nitrogen or other cryogenic fluids

Hazard Mitigation:

- Insulation on cold surfaces
- Review of installation and operating procedures by the safety committees
- Design reviews and functional testing before operations
- PPE such as goggles and face shields
- Work planning

KINETIC ENERGY HAZARDS

Possible Consequences:

- Physical injury (e.g., eye injury, broken bones, hearing loss, fatal injury, etc.)

Potential Initiators:

- Mis-operation of power tools
- Pressure testing with inappropriate vessels or piping
- Inadvertent contact with rotating or moving machinery
- Improper rigging of apparatus or shielding

Hazard Mitigation:

- Machine guards
- Only trained personnel allowed to operate tools or perform rigging operations
- Written procedures or supervisory participation in large equipment moves or pressure tests
- Critical lift review and approvals as per SBMS
- Design reviews and functional testing before operations
- Work planning

POTENTIAL ENERGY HAZARDS

Possible Consequences:

- Physical injury (e.g., eye injury, broken bones, hearing loss, etc.)

Potential Initiators:

- Release of stored energy associated with compressed gases
- Puncture of a vacuum window
- Improper hoisting operation

Hazard Mitigation:

- All equipment is designed to applicable codes and standards
- Operation and design reviewed by safety committees
- Vacuum window covers
- Design reviews and functional testing before operations
- Training and adherence to procedures by operators of compressed gas systems
- Only trained personnel allowed to perform hoisting operations

- Written procedures or supervisory participation in large equipment moves
- Work planning

4. Training Requirements

IONIZING RADIATION HAZARDS

- Radiological Worker I (HP-RWT002)
- Contamination/Airborne course and practical (HP-RWT-300/A)
- GE-64 - Contamination/Airborne Qualified
- Collider-Accelerator Access (AD-CA_ACCESS)

HAZARDOUS OR TOXIC MATERIAL HAZARDS

- Beryllium Use at BNL (TQ-BERYLLIUM1)
- Blood borne Pathogens Awareness (TQ-BBP)
- Cadmium Training for HazCom Operations (TQ-CADMIUM)
- Chemical Protective Clothing User Training (HP-OSH-157)
- Lead in the Workplace (TQ-LEAD1)
- Methylene Chloride Training for HazCom Operations (TQ-MCAT)

FLAMMABLE OR COMBUSTIBLE MATERIAL HAZARDS

- Fire Watch (HP-FRF-202)
- Emergency Planning and Response (GE-EMERGPLAN) (Initial Train)

ELECTRICAL ENERGY HAZARD

- Electrical Safety I (TQ-ELECSAF1)
- Lock Out/Tag Out Authorized Employee Training(HP-OSH-151B-W)
- Electrical Safety Work Practices (AD-ELECSAFETY)
- Department Specific Lockout Tagout (AD-LOTO-OJT)

OXYGEN DEPLETION HAZARDS

- Oxygen Deficiency Hazard (TQ-ODH)
- Oxygen Deficiency Hazard - Class 1 (TQ-ODH1)
- Oxygen Deficiency Hazard Practical ((AD-ODH-1-TRG)

MAGNETIC FIELD AND ELECTROMAGNETIC RADIATION HAZARDS

- Static Magnetic Fields (TQ-SMF)

THERMAL ENERGY HAZARDS

- General Employee Training (HP-V-001) (Initial Train)

CRYOGENIC TEMPERATURE HAZARDS

- Cryogen Safety (HP-OSH-025)

KINETIC ENERGY HAZARDS

- Noise and Hearing Conservation (TQ-NOISE)
- Crane Safety (HP-Q-010)
- Crane Operator Practical (HP-Q-010)

POTENTIAL ENERGY

- Lock Out/Tag Out Affected Employee Training (HP-OSH-151A-W)
- Lock Out/Tag Out Authorized Employee Training(HP-OSH-151B-W)
- Confined Space Entry (HP-OSH-016)
- GE-81 - Fall Protection-Qualified
- Stop Work Procedure Training (GE-STOPWORK)
- Crane Safety (HP-Q-010)
- Crane Operator Practical (HP-Q-010)

5. Regulatory Determination of Process

(Identify Applicable OPMs; See OPM 1.10.4.a, Flow Down Matrix for Higher Level Documents)

IONIZING RADIATION HAZARDS

- 2.5 Operational Safety Limits/Accelerator Safety Envelope for AGS, Booster and Linac
- 2.5.1 Accelerator Safety Envelope Parameters for C-A Tandem Van de Graaff
- 2.5.2 RHIC Accelerator Safety Envelope Parameters
- 4.1 C-A Complex Access Control Procedures for Primary Beam Enclosures
- 9.1.1Procedure for Obtaining Review by C-A Radiation Safety Committee
- 9.5.1 C-A ALARA Policy and Responsibilities

HAZARDOUS OR TOXIC MATERIAL HAZARDS

- 1.8 Hazard Communication Procedure
- 8.24 Use of Beryllium

FLAMMABLE OR COMBUSTIBLE MATERIAL HAZARDS

- 1.9 Fire Safety Program
- 2.5 Operational Safety Limits/Accelerator Safety Envelope for AGS, Booster and Linac
- 2.5.1 Accelerator Safety Envelope Parameters for C-A Tandem Van de Graaff
- 2.5.2 RHIC Accelerator Safety Envelope Parameters

ELECTRICAL ENERGY HAZARD

- 1.5 Electrical Safety Implementation Plan
- 2.6 Lockout Tagout Procedure for Personnel Entry into the AGS or Booster Ring
- 9.2.3 Procedure for Chief Engineers to Certify the Conformance of Devices
- 9.3.4 Review and Approval of Electrical Equipment Built In-House

OXYGEN DEPLETION HAZARDS

- 3.15 Response to Low Oxygen Alarm in ODH Class 0 and 1 Areas
- 4.44 Operation of PASS
- 12.11 Oxygen Deficiency Hazard Response (Tandem)

MAGNETIC FIELD AND ELECTROMAGNETIC RADIATION HAZARDS

- 9.2.1.d Threshold Limit Values For Magnetic Fields

THERMAL ENERGY HAZARDS

- 9.3.1 Procedure for Reviewing Conventional Safety Aspects of a C-A System

CRYOGENIC TEMPERATURE HAZARDS

- 7.1.39 Cryogenic Group Lockout/Tagout
- 9.6.1 Cryogenic System Review

KINETIC ENERGY HAZARDS

- 1.17 C-A Hearing Conservation Program
- 8.25 Material Handling and Lifting Safely: Equipment and Procedures

POTENTIAL ENERGY

- 1.6 Mechanical System(s) Safety Implementation
- 2.6 Lockout Tagout Procedure for Personnel Entry into the AGS or Booster Ring
- 8.14 Confined Space Entry Procedure

6. Assessment from Workers Health Surveillance

(Review Injury Statistics for Area From SHSD Spread Sheet And Injury Report)

Hazard Description	1 Injury/Illness Description	3 Number of Injuries/Illness 2000-2002	4 Number of Critiques for year 2000-2002	5 Number of Occurrences for year 2000-2002	6 Injury Sum add columns 3,4 and 5
Ionizing Radiation Hazards			4	1	5
Hazardous Or Toxic Material Hazards			3	0	3
Flammable Or Combustible Material Hazards			2	0	2
Electrical Energy Hazard			6	2	8
Oxygen Depletion Hazards			2	0	2
Magnetic Field And Electromagnetic Radiation Hazards			0	0	0
Thermal Energy Hazards			0	0	0
Cryogenic Temperature Hazards			0	0	0
Kinetic Energy Hazards	Neck Laceration Back Strain Knee Strain Nose Laceration Amputation of Finger Tip	1 2 1 1 1	1	0	7
Potential Energy			0	2	2

7. Risk Assessment

(Using Risk Matrix, Table 1)

Hazard ID	Risk Level Scale
Ionizing Radiation Hazards	**2**
Hazardous Or Toxic Material Hazards	**1**
Flammable Or Combustible Material Hazards	**3**
Electrical Energy Hazard	**2**
Oxygen Depletion Hazards	**2**
Magnetic Field And Electromagnetic Radiation Hazards	**1**
Thermal Energy Hazards	**1**
Cryogenic Temperature Hazards	**2**
Kinetic Energy Hazards	**1**
Potential Energy	**2**

8. Risk Metrics

List hazards; rank them using Tables 1 and 2; multiply the scores to get an Relative Risk Level.

Hazard ID	1	2	3	4	
	Scope Scale	Risk Level Scale	Compliance Scale	Injury Sum	Relative Risk Level, product of columns (0=1) 1-4
Ionizing Radiation Hazards	3	2	4	5	120
Hazardous Or Toxic Material Hazards	3	1	3	3	27
Flammable Or Combustible Material Hazards	3	3	2	2	36
Electrical Energy Hazard	3	3	2	8	144
Oxygen Depletion Hazards	3	2	2	2	24
Magnetic Field And Electromagnetic Radiation Hazards	3	1	1	0	3
Thermal Energy Hazards	3	1	1	0	3
Cryogenic Temperature Hazards	3	2	1		6
Kinetic Energy Hazards	3	3	1	7	63
Potential Energy	3	2	2	2	24

9. Hazard Minimization Opportunities for Accident Prevention

(Select the four highest Overall Risk Levels from Section 8)

1. Electrical Energy Hazards
2. Ionizing Radiation Hazards
3. Kinetic Energy Hazards
4. Flammable or Combustible Hazards

On October 2, 2002 Derek Lowenstein, C-A Department Chair, charged an ad hoc Electrical Safety Review Committee to review non-compliances reported in external and internal assessments. The Committee determined that LOTO log books are not always used to record LOTO and that it was a time-consuming task to associate a given LOTO tag with a particular logbook entry at C-AD. The Committee determined that alternate web-based LOTO systems appear to be potentially useful for tracking individual LOTOs, for tracking LOTO evolutions, and for issuing LOTO tags. The ad hoc Committee also determined that used LOTO tags and stubs should be destroyed after use; again to avoid the appearance of non-compliance.

The Committee also determined that up to date one-line drawings are needed in order to ensure that the correct protective equipment is chosen when working hot. The Committee clarified that verifying a LOTO is working hot if the testing equipment is manipulated by hand. The committee determined that the Department lacks a written grounding plan for accelerators and beam lines. These issues and other issues associated with training were addressed in the ad hoc Committee's recommendations, and are identified as an opportunity for an injury reduction initiative.

Radiological hazards are controlled and recent assessments have demonstrated compliance. For FY02, the collective dose was 21.3 person-rem. The Department ALARA dose goal for FY02 was 23 person-rem. Thus, we were within our goal. New initiatives for dose reduction are not needed at this time; however, increased vigilance on the use of RWPs is appropriate. Additionally, self-reading dosimeters need to be replaced since units in the field have unsafe battery failures.

Employee awareness of safety was increased through participation in Laboratory Safety Day. Participation is planned to continue if Laboratory Safety Day is adopted as an annual event at BNL. A review of safety behavior at Collider-Accelerator was performed by consultants from Dupont in January 2003. Their recommendations are being reviewed by a Laboratory Safety Improvement Team, and C-AD has representation on the team. At the Department level, kinetic energy hazards and flammable/combustible hazards are being addressed by implementing an OSH management system similar to OSHAS 18001 and ILO-OSH-2001. Several features of the OSH management system include:

- Creation of a Worker Occupational Safety and Health Committee
- An annual Management Review similar to ISO 14001
- Annual audit by the QA Group against OSH requirements in SBMS and requirements set down in Department level OSH management documents

10. Injury/Illness Reduction Initiatives

Hazard ID	New OPM, Inspection Process, or Other Mechanism	ATS , ADS Number or Reference
Electrical Energy Hazards	Review electrical safety issues at C-A through an Ad Hoc Electrical Safety Review Committee. Review and implement appropriate corrective actions recommended by Office of Independent Oversight during an Electrical Safety Review at C-AD. Implement corrective action recommended by the Ad Hoc Committee; for example, implement a Web Based LOTO data entry/Tag system.	ATS-1425 ATS-1425.2 ATS-1425.1.8
Ionizing Radiation Hazards	Increase awareness of employees through the use C-A facility training emphasizing the use and requirements of RWPs. Replace defective Siemens SRDs and distribute new SRDs to C-A personnel. Conform to SBMS, Rad-Con, and DOE requirements for radiation safety.	C-A Access Training Guide Radiation Safety Link
Kinetic Energy Hazards	Increase employee awareness of safety through participation in Laboratory Safety Day. Perform a management review of OSH. Increase safety and heath awareness and participation of all C-A staff through the implementation of C-A OSH. (OSH Management System Program Description)	OPM 1.10.4 OPM 1.10.4
Flammable and Combustible Hazards	Update of C-AD Accelerator Safety Envelopes for managing response to fire alarms. Perform and review emergency response drills at C-A. Replace various Fire Alarm Panels in building 930.	OPM 2.5 ATS-1382 ADS-AA2D0076

The Risk Matrix (Table 1)

↑ ***Consequence Level***

High	Low Risk – Acceptable *(Risk level 2)*	Medium Risk- Unacceptable *(Risk level 3)*	High Risk- Unacceptable *(Risk level 4)*	High Risk- Unacceptable *(Risk level 4)*
Medium	Extremely Low Risk - Desirable *(Risk level 1)*	Low Risk – Acceptable *(Risk level 2)*	Medium Risk- Unacceptable *(Risk level 3)*	High Risk- Unacceptable *(Risk level 4)*
Low	Extremely Low Risk - Desirable *(Risk level 1)*	Extremely Low Risk - Desirable *(Risk level 1)*	Low Risk – Acceptable *(Risk level 2)*	Medium Risk- Unacceptable *(Risk level 3)*
Extremely Low	Extremely Low Risk - Desirable *(Risk level 1)*	Extremely Low Risk - Desirable *(Risk level 1)*	Extremely Low - Desirable *(Risk level 1)*	Low Risk – Acceptable *(Risk level 2)*
	Extremely Unlikely ($<10^{-4}$/y)	**Unlikely (Between 10^{-4}/y and 10^{-2}/y)**	**Anticipated(Note) Medium (Between 10^{-2}/y and 10^{-1}y)**	**Anticipated (Note) High (Above 10^{-1}y)**

Likelihood of Occurrence →

Definition of Consequence Levels

- Extremely Low: Will not result in a significant injury or occupation illness or provide a significant impact on the environment.

- Low: Minor onsite with negligible or no offsite impact. Low risk events are events that may cause minor injury or minor occupational illness or minor impact on the environment.

- Medium: Medium risk events are events that may cause considerable impact onsite or minor impact offsite. Medium risk events may cause deaths, severe injuries or severe occupational illness to personnel or major damage to a facility or minor impact on the environment. Medium risk events are events from which one is capable of returning to operation.

- High: High-risk events may cause serious impact onsite or offsite. High-risk events may cause deaths or loss of facility/operation. High-risk events may cause significant impact on the environment.

Note: 10CFR835 may require limits that are more stringent for anticipated events.

Risk Metrics (Table 2)

List hazard, rank them using the scale below, four being the <u>most</u> significant.

Scale	Scope of Hazard Impact Scale	Outcome of Compliance Failure Scale
1	**Unnoticeable (Low)**	**Minimal**
2	**Only one work area (Low)**	**Record keeping, warning only**
3	**Organization wide (Moderate)**	**Department Penalty**
4	**Impact Outside of the organization (High)**	**Civil /Criminal Penalty, fine**